DOCUMENT RESUME

ED 476 700 SE 067 859

AUTHOR	Herbert, Susan
TITLE	Collateral Learning in Science: One Student's Response to a Cross-Cultural Unit of Work. A Case Study.
PUB DATE	2002-03-00
NOTE	14p.; Paper presented at the International Conference on Problems and Prospects of Education in Developing Countries (Barbados, March, 25-28, 2002).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS
DESCRIPTORS	*Concept Formation; Learning Processes; Learning Theories; *Science Curriculum; Science Instruction; Secondary Education

ABSTRACT

The purpose of this study was to investigate the nature of students' responses to an innovative curriculum unit in which I attempted to help students build bridges between traditional practices and beliefs about aspects of health and conventional western science concepts. This paper reports on the responses of one articulate student, who has given the pseudonym Lystra. Lystra was a member of a class of forty students whose ages range between 12 and 17 years and who attended a secondary school that was situated in a rural community. The class was exposed to a unit of five lessons that was designed to help students to access conventional western science concepts by comparing the traditional and western science ways of knowing. Lystra's responses obtained from classroom discussions and activities and pre- and post tests on the unit were analyzed qualitatively in order to discern themes and patterns. Further post-hoc analysis of the responses within Jegede's (1995) collateral learning model revealed that Lystra had engaged in parallel, dependent, and secured collateral learning. The implications for further research into science teaching and into the assessment of science learning are discussed. (Contains 23 references.) (Author)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 476 700

Collateral learning in science: One student's response to a cross-cultural unit of work
A case study

A paper presented at the International Conference on
Problems and Prospects of Education in Developing Countries
Barbados, March 25-28, 2002

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL IN MICROFICHE,
AND IN ELECTRONIC MEDIA FOR ERIC
COLLECTION SUBSCRIBERS ONLY,
HAS BEEN GRANTED BY

S. Herbert

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

2A

Susan Herbert
School of Education
UWI
St. Augustine
Republic of Trinidad and Tobago
West Indies

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

BEST COPY AVAILABLE

SE067859

Abstract

The purpose of this study was to investigate the nature of students' responses to an innovative curriculum unit in which I attempted to help students build bridges between traditional practices and beliefs about aspects of health and conventional western science concepts. This paper reports on the responses of one articulate student, who was given the pseudonym Lystra. Lystra was a member of a class of forty students whose ages ranged between 12 and 17 years and who attended a secondary school that was situated in a rural community. The class was exposed to a unit of five lessons that was designed to help students to access conventional western science concepts by comparing the traditional and western science ways of knowing. Lystra's responses obtained from classroom discussions and activities and pre- and post tests on the unit were analysed qualitatively in order to discern themes and patterns. Further post-hoc analysis of the responses within Jegede's (1995) collateral learning model revealed that Lystra had engaged in parallel, dependent, and secured collateral learning. The implications for further research into science teaching and into the assessment of science learning are discussed.

Introduction

The dominant view of science during the 1960s and 70s was as a universal, value-free, objective way of knowing. Within recent times, however, some researchers (Aikenhead, 1996, 1997; Baimba, 1993; George, 1995; Hewson, 1988; Jegede, 1997) have expressed another view of science- one that depicts science as a cultural phenomenon. They posit that science is a sub-culture of western societies- a way of knowing that is circumscribed by the norms, values, beliefs, and actions of a sub-group within western societies. As such, they contend that science is a unique way of thinking that often requires students, especially those from non-western societies, to cross boundaries from their culture into that of the sub-culture of science. This way of thinking about science has come at a time when there is a climate of educational reforms in which science teachers are being asked to rally around the clarion call of "Science for All" by emphasizing the relevance of science curricula for everyday living.

When we examine the implications of these perspectives, the message to practitioners is clear. If we are to cater for all of our students for life in today's scientific and technological world, it is important, firstly, that science teachers identify the unique needs of the students in the context in which they practise and, secondly, that they address these needs so that students can deal adequately with issues related to science and technology. Therefore, there have been calls for "multicultural science curricula" or "cross-cultural science curricula" (Aikenhead, 1997; George, 1995; George & Glasgow, 1999; Hodson, 1992; Jegede,1995 ; Snively, & Corsiglia, 2000; Waldrip & Taylor, 1999), and culturally relevant pedagogy (Ladson-Billings, 1995). The thinking is that these curricula would operationalize the traditional Ausubelian principle that teaching must begin where the learner is. To do so, the teacher must be cognisant of the students' prior knowledge and then use this knowledge in the classroom.

In the Caribbean, George (1986) and George and Glasgow (1988) have pioneered research into students' prior knowledge, which may impact on their understanding of conventional science concepts. In 1986, George recognized that traditional customs and beliefs were a part of students' prior knowledge, and she used the term "street science" to describe these traditional customs and beliefs. This "street science" was often very different from the "western science" that was presented in the science classroom. Later, George (1995) continued her research on "street science," and she conducted an in-depth study of the traditional practices and beliefs of a rural community, "Seablast," situated in Trinidad and Tobago. She discovered that traditional practices and beliefs constituted the prior knowledge of many persons who resided in "Seablast." For example, George (1995, p.93) discovered that "one of the principles that is still fairly prominent is the principle relating to heat and cold. A 'heated' human body should not be exposed suddenly to cold environments." She also found that "there exists a system of practices which acknowledges food as being essential for the functioning of the human body but which also acknowledges that food contributes to body disfunctions. The cycle of "cooling/ purging/ building up is based on this principle" (p.112). These principles undergird the practices of many villagers of Seablast.

Based on these findings, it is evident that the students who live and attend school in Seablast are exposed to alternative ways of explaining many of the health related issues that are addressed in the formal science classroom. George (1995) believes that, in principle, any unit of work that addresses health-related matters should take these traditional ideas on board. She advocates that there should be further research into this aspect of science teaching/learning. In responding to this suggestion, I developed a unit of work for students at Seablast in which I attempted to build bridges between students' traditional practices and beliefs and conventional science concepts. The bridge-building device used in this unit was the comparison of traditional practices and beliefs with conventional science concepts.

The purpose of the study, then, was to explore the nature of the students' responses to this curriculum unit when different forms of assessment items were presented. This paper reports on one student's understandings prior to, during, and after the enactment of the unit.

Theoretical underpinnings

In the new thrust towards science for all, educators have proposed a variety of innovative ways to make the science curriculum relevant to an increasingly diverse student population. Many of these innovations have been undergirded by cognitive theories of learning and by constructivism as a way of thinking about the nature of knowledge. Cognitive theories of learning and constructivism have the common premise that students' prior knowledge is a perceptual lens through which incoming experiences are filtered, as they attempt to make sense of phenomena.

An implicit aim of many of the instructional approaches in science education that is based on cognitive theory has been conceptual change (Posner, Strike, Hewson, & Gerzog, 1982). For science educators who subscribe to this view, one of the main criteria for successful instruction is that students would have replaced their prior concepts with the currently accepted western science concepts. Other educators criticise this view of science learning, which they describe as acculturation. They suggest that the aim of acculturation is to assimilate minority groups into the dominant world view (Aikenhead, 1996, 1997; Hodson, 1992; Ogawa, 1995).

Many years of science education research have revealed that the students' prior conceptions are very resilient (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Osborne & Freyberg, 1985; Solomon, 1983, 1987), and this finding is often interpreted to mean that the students have not accessed the conventional science concepts that were presented in the classroom. In 1995, Jegede put forward a different view of learning that he termed "collateral learning," which provides an alternative to the conceptual (ex)change model as a way of describing and predicting the learning outcomes when students, particularly those from non-western societies, are exposed to the culture of science in the formal classroom.

Jegede (1995, p. 117) defined collateral learning as "an accommodative mechanism for the conceptual resolution of potentially conflicting tenets within a person's cognitive structure." He proposed four types of collateral learning- parallel, dependent, simultaneous and secured- that fall on a continuum in which parallel collateral learning and secured collateral learning are on opposite

poles. Parallel collateral learning is said to occur when students hold conflicting concepts in long term memory. There is no interaction between these concepts, which are used in different contexts. Secured collateral learning, on the other pole, occurs when there is conscious interaction between conflicting schemata. The result of the interaction is either a restructuring of the schemata in which there is "convergence towards commonality by one schema reinforcing the other" (Aikenhead & Jegede, 1999, p.278) or the scenario in which persons are aware of both schemata and have an adequate reason for maintaining both sets of concepts. Dependent collateral learning results in an amalgamation or a "well stirred mix" of ideas, but persons are not conscious that their understandings are informed by different ways of knowing. The fourth type, simultaneous collateral learning, is the term used when both sets of concepts are learnt at the same time, and they reinforce each other.

Congruent with the collateral learning model is the view of science learning as border crossing (Giroux, 1992). This term "border crossing" is a useful metaphor whenever alternative ways of knowing/explaining similar phenomena are identified. It captures the idea that knowledge is situated within various cultural contexts and that we can make excursions from one way of knowing to another as we attempt to explain phenomena. As happens when we physically travel to a new country, it means that at the mental level, there can be border crossings. For example, there are border crossings from common sense notions to science concepts and from traditional ways of knowing to conventional science concepts.

Researchers such as Jegede (1995), Aikenhead (1997) and others posit that this thinking is appropriate for science curricula to which First Nation Peoples and persons from developing countries are exposed because the students' prior knowledge is honored and, at the same time, the students can benefit by accessing the cultural capital of western science, as they see fit. Science learning is viewed as autonomous acculturation, which according to Aikenhead (1997, p. 230) happens when

> a student borrows or adapts (incorporates) some content from Western science and teachnolgy because the content appears useful to him/her, thereby replacing some former indigenous views. Everyday thinking is an integrated combination of common sense thinking and some science/technology thinking.

This view acknowledges that students make their own decisions about the explanations that they accept.

The collateral learning model has been applied successfully to research findings that have been reported in the literature from First Nations Peoples, Africans, and Trinidadians (Aikenhead & Jegede, 1999), and is also evident in the work of researchers such as Ogawa (1995) in Japan and Ogunniyi (1988) in Nigeria. To date, however, there is a paucity of empirical data on the outcomes of science teaching in Trinidad and Tobago to which the collateral learning model may be applied. Trinidad and Tobago is normally classified as a developing country with a rich traditional heritage that is juxtaposed against modern international global perspectives. These

conditions seemed to favour the adoption of the cross-cultural approach to science learning.

Procedure

This instrumental case study (Stake, 1995) is located within the qualitative paradigm. Lystra, the student who comprised the case, was a member of a class of forty students who were between the ages of 12 to 17 years. She was chosen because she was a very articulate student with good literacy skills. She attended science lessons regularly, and she was punctual.

The students were exposed to a unit of work entitled "Maintaining Health." The unit taught consisted of five lessons entitled *"Cold or Not?" "The common cold: Catch me if you can," "Cooling-Off," "Cooling: A home remedy,"* and *"Pimples and the adolescent."* These lessons were developed to build bridges between the principle related to heat and cold and the cycle of cooling/purging/building -up, that were identified by George (1995) as underpinning many of the practices of the villagers who resided in Seablast, and conventional science concepts.

Each lesson was enacted during one science session per week over a period of 8 weeks, and each session lasted for ninety minutes. The classroom sessions were audio taped, transcribed, and analysed by a process of coding and categorizing. Prior to, and at the end of the unit, the students were given a test which comprised two main types of items. In one type the students were asked for their personal explanations, by explicit use of the term "*you*" in the phrasing of the question. This item was meant to elicit the explanation that the student had accepted. In the other items, the students were provided with cues that were intended to elicit the western science explanation. For example, in the latter type of items, the terms *"the science teacher"* or *"the science textbook"* were used to provide the science context. These different item types were intended to cater for instances where students may have accessed the conventional science concepts, but may not necessarily have accepted them. All the data that were contributed by Lystra were analysed qualitatively.

Findings

Analysis of the pre-test results indicated that Lystra used traditional concepts to explain the occurrence of the common cold. In responding to the other items, which required explanations of other health-related conditions- the appearance of pimples- or everyday phenomena- "cooling-off"- she employed conventional science concepts and/or her everyday common sense constructions. For example, her explanation about the appearance of pimples contained the conventional science term "puberty" along with everyday notion that dirt is a contributing factor. The traditional belief is that pimples appear when there is excess "heat" in the body (George, 1995).

A comparison of the pre-test responses with those on the post-test indicated that Lystra had accessed many of the conventional science concepts presented in the lessons. Lystra had learnt science, and this learning was demonstrated in different ways. Firstly, Lystra's responses showed that some of her prior ideas were restructured. There was a change from mixed

explanations about phenomena addressed in the lessons *"Cooling-Off"* and *"Pimples and the Adolescent"* to the use of conventional science concepts only- an indication of secured collateral learning. Secondly, on the post-test some phenomena were explained with ideas from both world views, depending on the context cues presented. For example, there were cases in which Lystra gave the traditional practice or belief as her personal explanation and the western conventional science explanation when cued specifically for the science explanation. These latter findings were examples of parallel collateral learning because Lystra used her prior knowledge when the item allowed her to express her personal views, however, when cued explicitly for the western science explanation, she accessed the appropriate western conventional science concepts. Finally there were instances when Lystra produced a seemingly unconscious, well-stirred mix of ideas- indicative of dependent collateral learning.

The details of the analysis are presented below, beginning with examples of secured collateral learning. Lystra demonstrated that she had constructed new conceptions that reflected the conventional science concepts and which reflected a convergence of those aspects of her original explanation that were similar to the conventional science explanation. Immediately following these are examples of parallel collateral learning and dependent collateral learning.

Secured Collateral learning: Restructuring schema

The comparison of the pre/ post-test responses based on the lessons *"Cooling-Off"* and *"Pimples and the adolescent,"* revealed that Lystra built on her prior conventional science notions to construct a fuller explanation of the phenomena discussed.

In response to the question " **What is the purpose of sweating?"** that was based on the lesson *"Cooling-Off"*, Lystra revealed some restructuring of schemata. Her explanation changed from a statement that comprised commonsense ideas about the removal of excess water and dirt to one in which she focused on water (now called perspiration) and included the conventional science concept that perspiration leads to a cooling effect on the body:

> **Pre:** So it can bring out the excess water, dirt, you burn energy while sweating.
> **Post:** Is when your body heat rises so it causes perspiration so your body could (feel cool) warm.

Similarly, on the item based on the lesson entitled *"Pimples and the adolescent,"* Lystra showed that she had restructured her original explanation that puberty and dirt were both factors that contributed to the appearance of pimples. On the post-test, she revealed that she had constructed a fuller understanding of the conventional science explanation of puberty by including the conventional science concepts of the role of hormones and bacteria. Lystra had retained the scientific notion of puberty in response to the item that requested a personal explanation about the cause of pimples. However, she changed from a concrete explanation about dirt that is visible to an abstract explanation about hormones and bacteria:

Your young brother says: "I don't understand why you have pimples on your skin." Write what <u>you would say</u> to explain to him why you have pimples,

> **Pre:** Because when someone grows old they come into the stage of puberty. From dirt left on your skin. And everyone goes through a stage of puberty. And puberty is harsh on some people.
> **Post:** I have pimples because it's a part of growing up when you reaches the stage of puberty there are changes in your body. The hormones and bacteria reacts to your body.

The pre/ post tests also contained an item based on the lesson entitled *"Pimples and the adolescent"* in which students were explicitly cued for the science explanation: **Let's tell you the reason that <u>our science teacher</u> gives for the appearance of pimples**. On the pre-test, Lystra used the everyday notion that pimples are caused by the dirt that is left on the skin. At the end of the unit, she gave a scientific explanation that was similar to her personal explanation:

> **Pre:** Pimples is left on the skin by <u>excess dirt</u> on the skin stage of pimple.
> **Post:** The <u>hormones in your body and the bacteria</u> reacts to the germs in your body and when you're growing up and you reach the stage of puberty you get acne.

It is clear that on the post- test, there was convergence of the personal and science explanations based on the conventional science concept of puberty and the associated concepts of bacteria and hormones

<u>Parallel collateral learning</u>

Two other items on the tests provided evidence that Lystra had engaged in parallel collateral learning. In responding to an item on the pre/post test in which her personal explanation about the cause of the common cold was requested, Lystra invoked the traditional concept that a sudden temperature change would cause the cold. She spoke, for example, about the effects of water, or moving from the sun to the fridge. However, she qualified her post-test response by using the word "some" before the word "people":

How would <u>you</u> explain how people "catch the cold?"

> **Pre:** People catch cold by staying in the water too long. As you come from in the sun you sometimes go in front of the fridge. Ironing then bathing (with the coal pot iron). As you get up you take a shower without cooling out yourself.
> **Post:** Some people catch the cold by getting wet in the rain and doesn't dry their

hair properly. After ironing going and bathe in cold water. After waking up and taking a cold shower right away.

When the science context was overtly established by use of the cue "science class," Lystra demonstrated that she had accessed the conventional science concept that germs cause the cold. In response to the item- **During science class, Kevon read an explanation from his science textbook of how people catch the cold. Describe what might have been written in the science textbook,** Lystra replied:

> **Pre:** They will tell you ways people get cold. Like playing in the rain long and without drying your hair properly. Sneezing, wheezing and coughing. Having a sick feeling.
> **Post:** It might have said by transferring or giving someone the cold. Like when someone sneeze and doesn't cover their mouth the germs from them is spred to other individuals.

Dependent collateral learning

Lystra's responses to the test item that requested her explanations for the properties of materials revealed dependent collateral learning in which there was unscious mixing of ideas from traditional wisdom and conventional science ways of knowing. The students were presented with the following scenario:

> **A class meeting was in progress when Wendy and Jane entered the air-conditioned room. There were only two chairs left. Both girls sat down, but Jane immediately jumped up with a screech: "Ahh! This chair is cold. You sat on the warm chair!" Do you agree with Jane's statement that one chair is cold and the other is warm?**

A comparison of the pre/post-test results revealed that Lystra had changed her response from "it is cold" to "it feels very cold." That is, she changed from an explanation based on the intrinsic property of materials to one that conveys the idea of an interaction of person with metal. She had accessed the conventional science concept. However, she maintained the notion of intrinsic property of materials when she said: "it will be warm."

> **Pre:** Yes. I agree that Jane's statement that the chair is cold because when sitting on metal or iron it's a very exposed piece of metal so it becomes cold.
> **Post:** Because when a metal chair is exposed it feels very cold when you sit down on it and the cloth covering material will be very warm.

The data analysis also revealed that during the enactment of the unit, Lystra had made

comments that revealed dependent collateral learning. Evidence for this type of collateral learning occurred during one classroom session. Students were given the opportunity to play a game as a means of reviewing their understandings about the traditional and conventional science ways of explaining the common cold. In response to the question: **What is the cause of the common cold?** Lystra said:

> Lystra: Playing in the rain, sleeping with wet hair, going to bathe as soon as I get up. And am... what else? A virus.

Overall summary

At the end of the unit, there was evidence of parallel collateral learning in Lystra's responses to the items on the common cold. From Lystra's responses, the request for personalized explanations triggered traditional responses about the common cold. On the other hand, explicit cues for the science explanation allowed her to demonstrate that she had accessed conventional science concepts about the common cold even though she had used the traditional mode as her personal explanation. In dealing with items about the properties of materials, there was evidence of the adjustment of her schemata to include concepts presented in the class alongside her traditional knowledge. She constructed schema that embraced both world views, that is, she readjusted her "memory to accommodate the different view presented in the science classroom" (Jegede, 1995, p. 119)- evidence of dependent collateral learning.

The analysis also revealed that requests for personal explanations sometimes elicited the conventional science concepts. For example, in response to the items on the lesson entitled: *Pimples and the adolescent*, Lystra restructured her original mixed explanations about the cause of pimples by focussing on the aspects of her explanation that were similar to the conventional science concepts and developing these conventional science explanations about puberty. A similar restructuring was observed in the item about sweating in which the personalized term "you" was not used. These restructured responses seemed to indicate that secured collateral learning had occurred.

Discussion

It is evident that Lystra engaged in border crossing from traditional ways of knowing and everyday constructions to conventional science understandings and that she engaged in secured, dependent and parallel collateral learning. Aikenhead and Jegede (1999) note that border crossing from one one way of knowing to another is a complex phenomenon, the results of which are often unpredictable. For some students, there is an integration of knowledge that is reflective of a holistic world view; for others there is compartmenalization of knowledge, that is, a reflection of multiple worlds. The situation is even more complex because researchers/educators have different goals for cross-cultural teaching. For example, Waldrip and Taylor (1999) advocate secured collateral learning that is reflective of the holistic view. On the other hand,

Aikenhead and Jegede (1999) cite Lowe as being strongly supportive of parallel collateral learning and those secured collateral learners who are conscious of their multiple worlds. Whatever the stance taken by researchers, students' explanations will reflect their learning, which, as this study shows, may include their prior conceptions.

There are implications of these views and the findings of this study for the assessment of science teaching/ learning. Students who are exposed to conventional science learning in the formal science classroom may engage in secured or parallel collateral learning when their prior knowledge is not congruent with the concepts presented. As illustrated, by Lystra's responses the form in which the questions are presented can elicit students' various conceptions. Recall that when asked for personalized explanations about everyday experiences, like the common cold, Lystra used her prior knowledge of sudden temperature change as the cause, which was not congruent with the conventional science concept of the virus. But this response did not mean that she had not learnt the conventional science concepts. When cued explicitly for conventional science, Lystra presented the conventional science views about germs that are transferred from one person to another.

It is evident, then, that teachers who are involved in cross-cultural teaching must be conscious of the manner in which questions are posed. Additionally, examiners must be clear whether the students are being tested to determine if they have accessed the conventional science or whether they have personally accepted the conventional science explanation. My personal experience of correcting examination scripts for the Caribbean Examinations Council (CXC) is that some students may give a combination of explanations from different world views -which may be indicative of dependent collateral learning- when they are presented with stimulus material that includes everyday phenomena and they are asked for personal explanations as indicated by the terms "you" or "your" in the phrasing of questions What should be examiners' reactions to these responses? Should students be penalized when these responses are made? Or should the alternative explanations be recognized as evidence of collateral learning? If this latter position is adopted then the conventional science explanations therein can be rewarded without penalty. Or alternatively, should the examining body eliminate items in which there are requests for personalized explanations and adopt a policy in which students are cued explicitly for conventional science explanations? The findings of this study indicate the need for further research in this area.

References

Aikenhead, G.S. (1996). Science Education: Border crossing into the subculture of science. Studies in Science Education, 27, 1-50.

Aikenhead, G. (1997). Towards a First Nations cross-cultural science and technology curriculum. Science Education, 81, 217-238.

Aikenhead, G., & Jegede, O.J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. Journal of Research in Science Teaching, 36 (3), 269-287.

Baimba, A. (1993). Innovation in a science curriculum: A Sierra Leone case study. International Journal of Science Education, 15 (2), 213-219.

Driver, R., Asoko, H., Leach, J. Mortimer, E. & Scott, P. (1994). Constructing scientific knowledge in the classroom. Educational Researcher, 23 (7), 5-12.

George, J. (1986). "Street Science" in Trinidad and Tobago: Analysis and implications for teaching conventional science. Paper presented at the first Regional Consulation on Science Education Research in Latin America and the Caribbean, Trinidad.

George, J. (1995). An analysis of traditional practices and beliefs in a Trinidadian village to access the implications for science education. Unpublished doctoral dissertation. The University of the West Indies, St. Augustine.

George, J. & Glasgow, J. (1988). Street science and conventional science in the West Indies. Studies in Science Education, 15, 109-118.

George, J. & Glasgow, J. (1999). The boundaries between Caribbean beliefs and practices and conventional science. Monographs of the EFA in the Caribbean: Assessment 2000 (Serial No 10). Kingston: UNESCO.

Giroux, H. A. (1992). Border crossings. N.Y.: Routledge

Hewson, M. G.(1988). The ecological context of knowledge: Implications for learning science in developing countries. Journal of Curriculum Studies, 20, 317-386.

Hodson, D. (1992). Towards a framework for multicultural education. Curriculum, 13, 15-18.

Jegede, O. (1995). Collateral learning and the eco-cultural paradigm in science and mathematics education in Africa. Studies in Science Education, 25, 97-137.

Ladson-Billings, G. (1995). Toward a culturally relevant pedagogy. American Educational Research Journal, 32 (3), 465-491.

Ogawa, M. (1995). Science education in a multi-science perspective. Science Education, 79, 583-593.

Ogunniyi, M. B. (1988). Adapting Western science to traditional African culture. International Journal of Science Education, 10, 1-9.

Osborne, R., & Freyberg, P. (1985). Learning in science: The implications of children's science. Auckland: Heinemann

Posner, G., Strike, K., Hewson, P., & Gertzog, W. (1992). Accomodation of scientific conception: Toward a theory of conceptual change. Science Education, 66, 211-227.

Snively, G., & Corsiglia, J. (2000). Discovering indigenous science : Implications for science education. Science Education, 85 (1), 6-34.

Stake, R. (1995) The art of case study research. Thousand Oak, CA: Sage

Solomon, J. (1983). Learning about energy: How pupils think in two domains. European Journal of Science education, 5, 49-59.

Solomon, J. (1987). Social influences on the construction of pupils' understanding of science. Studies in Science Education, 14, 63-82.

Waldrip, B. G. & Taylor, P.C. (1999). Permeability of students' worldviews to their school views in a non-western developing country. Journal of Research in Science Teaching, 36 (3), 289-303.

SE067859

ERIC

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: COLLATERAL LEARNING IN SCIENCE: ONE STUDENT'S RESPONSE TO A CROSS CULTURAL UNIT OF WORK - A CASE STUDY	
Author(s): SUSAN HERBERT	
Corporate Source:	Publication Date:

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in th monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper cop and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the following three options and sign at the bottom of the pag

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

Level 1

☐

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.

The sample sticker shown below will be affixed to all Level 2A documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

Level 2A

☑

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only.

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2B

Level 2B

☐

Check here for Level 2B release, permitti reproduction and dissemination in microfic only.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contracto requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to sati information needs of educators in response to discrete inquiries.

Sign here please

Signature: Susan Herbert		Printed Name/Position/Title: SUSAN HERBERT / LECTURER	
Organization/Address: SCHOOL OF EDUCATION, UNIVERSITY OF THE WEST INDIES, ST AUGUSTINE, REPUBLIC OF TRINIDAD AND TOBAGO	Telephone: 1-868-645-3232 x 3337	FAX: 1-868-662-6615	
	E-Mail Address: sherbert@fhe.uwi.tt	Date: 29/4/03	

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS).

Publisher/Distributor:
Address:
Price Per Copy:
Quantity Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant a reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V.WHERE TO SEND THIS FORM:

You can send this form and your document to the ERIC Clearinghouse on Languages and Linguistics, which will forward your materials to the appropriate ERIC Clearinghouse.

Acquisitions Coordinator
ERIC Clearinghouse on Languages and Linguisitics
4646 40th Street NW
Washington, DC 20016-1859

(800) 276-9834/ (202) 362-0700
e-mail: eric@cal.org